

Hazardous Substances Emergency Events Surveillance Program

Ammonia Emergency Release Events in Washington State, 1993 – 2001.

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The HSEES Program

The Hazardous Substance Emergency Events Surveillance (HSEES) program, sponsored by the U.S. Agency for Toxic Substances and Disease Registry (ATSDR), tracks emergency releases of non-petroleum hazardous substances. Specific data on these events and their associated injuries are collected to provide information to be used by emergency planners or other interested parties. By educating people about the types of hazardous substance events that are occurring, the HSEES program hopes to assist in reducing the injuries and deaths that result from these emergency releases.

Ammonia....The Most Frequently Released Hazardous Substance

During the period of 1993 through 2001, ammonia was the most frequently released hazardous substance in Washington State. At normal temperatures ammonia is a colorless, corrosive, pungent gas, which is highly soluble in water and can be converted into liquid form by pressurization. Exposure to ammonia can irritate the eyes, nose, throat, lungs, and skin. Exposure to high levels of ammonia can cause headache, nausea, coughing, dizziness, shortness of breath, chemical burns, and death.

In Washington State, ammonia is used in the manufacture of fertilizers, plastics, and explosives; and is utilized as a refrigerant by the agricultural and fishing industries. Additionally, anhydrous ammonia is a key ingredient in the “Nazi” method of making the illegal drug, methamphetamine. Theft of anhydrous ammonia from agricultural and industrial facilities for the production of methamphetamine is an increasing problem and can result in unexpected releases.

From 1993 through 2001, a total of 387 releases of ammonia were reported to the HSEES program in Washington State. There were injuries associated with 124 of these events, with a total of 402 people having been injured due to ammonia releases. An evacuation order was given for 118 of these events, affecting more than 7,500 people.

Table 1. Ammonia-related HSEES Events, Injuries and Evacuations in the State of Washington, 1993 – 2001.

Year	Total HSEES Events	Ammonia Events (%)	Ammonia Events with Injuries (%)	People Injured	Ammonia Evacuations	People Evacuated*
1993	524	39 (7.4)	11 (28.2)	16	16	1505
1994	402	35 (8.7)	8 (22.9)	27	14	633
1995	448	34 (7.6)	10 (29.4)	32	11	464
1996	396	54 (13.6)	10 (18.5)	141	18	2373
1997	371	28 (7.6)	6 (21.4)	18	12	485
1998	396	41 (10.4)	12 (29.3)	27	9	508
1999	423	43 (10.2)	17 (39.5)	52	14	1389
2000	440	40 (9.1)	20 (50.0)	35	7	108
2001	522	73 (14.0)	30 (41.1)	54	17	62
Totals	3922	387 (9.8)	124 (31.1)	402	118	7527

*Unknown for 26 ammonia release evacuation events

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Table 1, above, shows the total HSEES events, ammonia release events, ammonia events with injuries, number of individuals injured due to ammonia releases, and the number of evacuations and people evacuated during ammonia events. Ammonia events accounted for almost 10% of the total HSEES events in Washington State from 1993 to 2001. Injuries were experienced about 31% of the time when an ammonia event occurred. An official evacuation order was given 31% of the time during these releases.

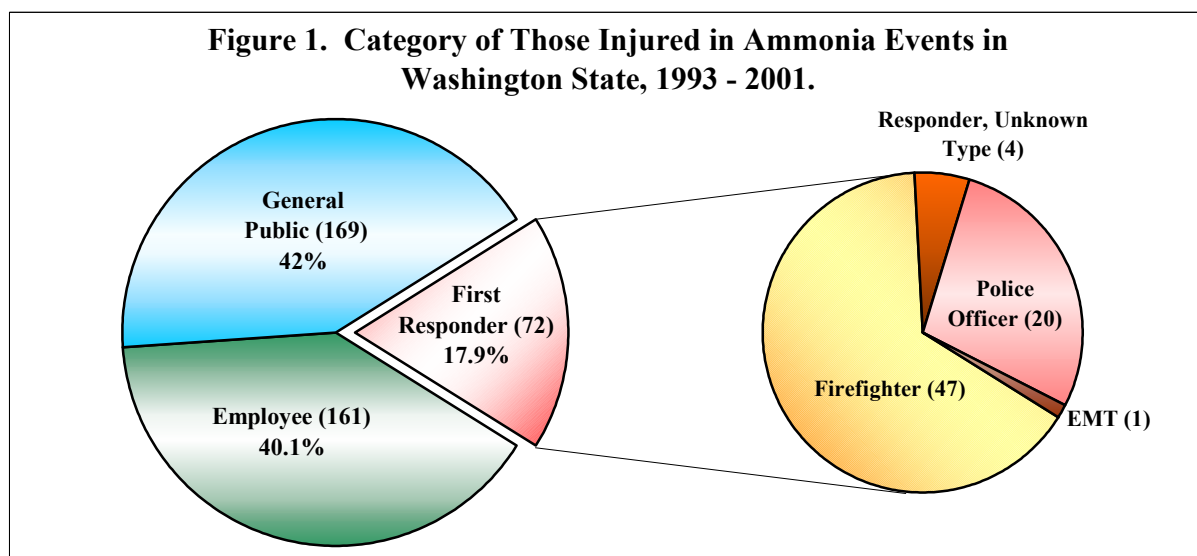
Examples of Ammonia Release Events in Washington State:

- In April of 1994, about 300 Seattle elementary school students were evacuated because of a two-gallon spill of ammonia in the janitor's storage room. One school employee experienced respiratory irritation and was treated at the scene. The fire department's hazardous materials team cleaned up the spill and removed the container.
- In April of 1996, an estimated 1,800 people were evacuated after an electrical fire broke out in a frozen food processing plant in Stanwood. The fire caused 18,000 gallons of ammonia and the contents of a one-ton tank of chlorine gas to be released. Ten members of the general public, five police officers, and one firefighter were treated for chemical-related injuries experienced during the incident.
- In May of 1996, a tanker truck at a fertilizer supply company in Walla Walla released 7,690 gallons of anhydrous ammonia to the air due to a hose seal breaking during transfer. About 200 people were evacuated within a five-block area of the release. While evacuating nearby businesses, two law enforcement officers experienced respiratory, eye, and skin irritation and were treated at the hospital. The potential for further injuries was mitigated by the fire department's use of a water fog to knock down the ammonia fumes.
- In August of 1996, 105 members of the general public were treated at hospitals after an anhydrous ammonia tank at an industrial gas company in Pasco released 2,000 gallons into the atmosphere. The tank had been overfilled causing the safety vent valve to release the ammonia. At least 250 people were evacuated from the area as the regional hazardous materials team, with assistance from local fire, police, and company responders, stopped the release.
- In November of 1998, five law enforcement officers were exposed to anhydrous ammonia from a methamphetamine drug lab found in a Tacoma residence. All experienced respiratory problems and were treated at a local hospital.
- In September of 1999, 100 pounds of anhydrous ammonia was released from a seafood processing plant in Renton due to an equipment failure. Eleven employees and eight members of the general public experienced injuries. An evacuation order was given and a six-mile stretch of interstate and several city blocks were closed.
- In May of 2002, a theft of anhydrous ammonia from a food storage facility in Arlington caused about 1,000 pounds to be released. Around 1,500 residents within a square mile

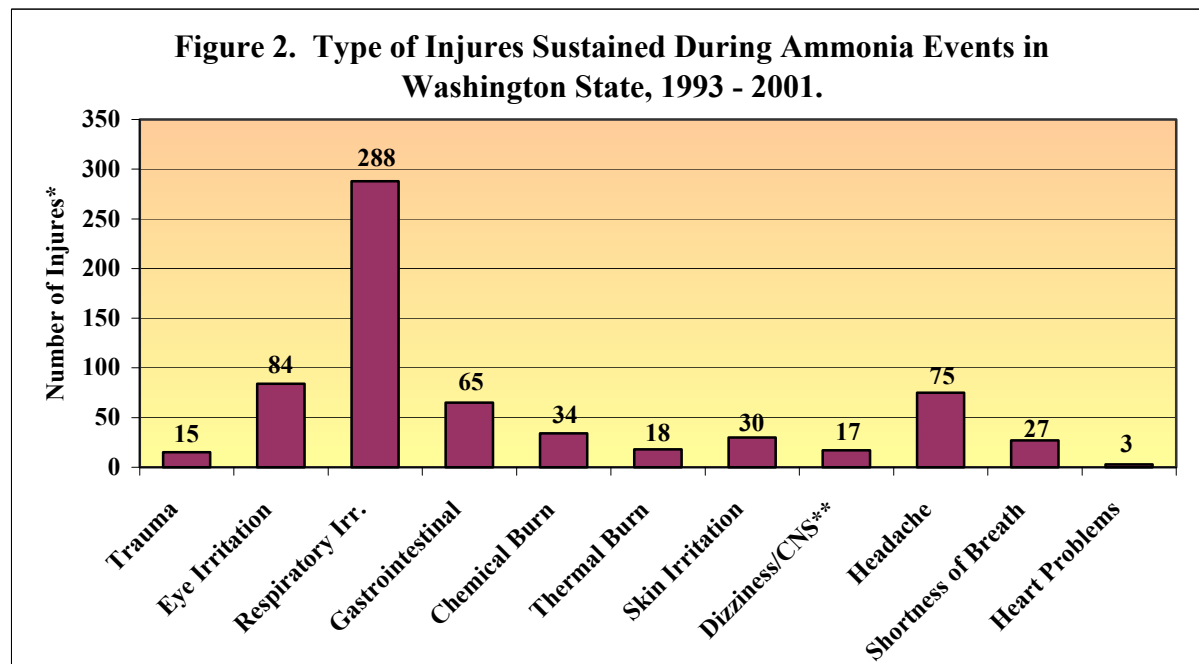
were evacuated and four people reported injuries. The five-hour evacuation closed all highways into the city as the county hazardous materials team shut off the release. (This 2002 event is not included in this report's data.)

Injuries

A total of 402 people were reported as having injuries related to ammonia release events during the nine years studied. Figure 1, below, shows the categories of those injured in ammonia events. Members of the general public accounted for 42% of the injuries, followed by employees with about 40%, and first responders with almost 18%. Of the 72 first responders who were injured, 47 (65.3%) were firefighters, 20 (27.7%) were law enforcement officers, one was an emergency medical technician, and four were responders of unknown type.



The types of injuries that occurred during ammonia events were grouped into eleven categories (Figure 2, below). About 44% of those injured had respiratory irritation, making it the most frequent injury sustained. Eye irritation (12.8%), headaches (11.4%), and gastrointestinal problems (9.9%) were the next most frequent injuries suffered. Just over 5% of those injured had chemical burns, 4.6% had skin irritation, and 4.1% experienced shortness of breath. Almost half (48.3%) of those injured reported more than one type of injury.



*A total of 656 injuries were reported. The number of injuries was greater than the number of victims because some victims had more than one injury.

**Central nervous system symptoms.

Release Factors

Data on primary factors contributing to ammonia releases was examined for 197 events and was collected from 1998 to 2001 (Table 2). Equipment failure caused about 41% of the ammonia release events. Operator error was indicated in just over 15% of the events. “Deliberate Damage/ Illegal Activity” was initiated as a factor in 2001 in an effort to better capture drug lab related release events, and was indicated in 45 events in its first year.

Table 2. Primary Factors Contributing to Ammonia Releases During HSEES Events in Washington State, 1998 – 2001.

Contributing Factor	1998	1999	2000	2001	Totals
Equipment Failure	24	26	16	15	81
Operator Error	4	5	12	9	30
Unknown Factor	10	3	5		18
Other*		9	3	4	16
Deliberate Damage	3		4	N/A	7
Deliberate Damage/ Illegal Activity**	N/A	N/A	N/A	45	45
Totals	41	43	40	73	197

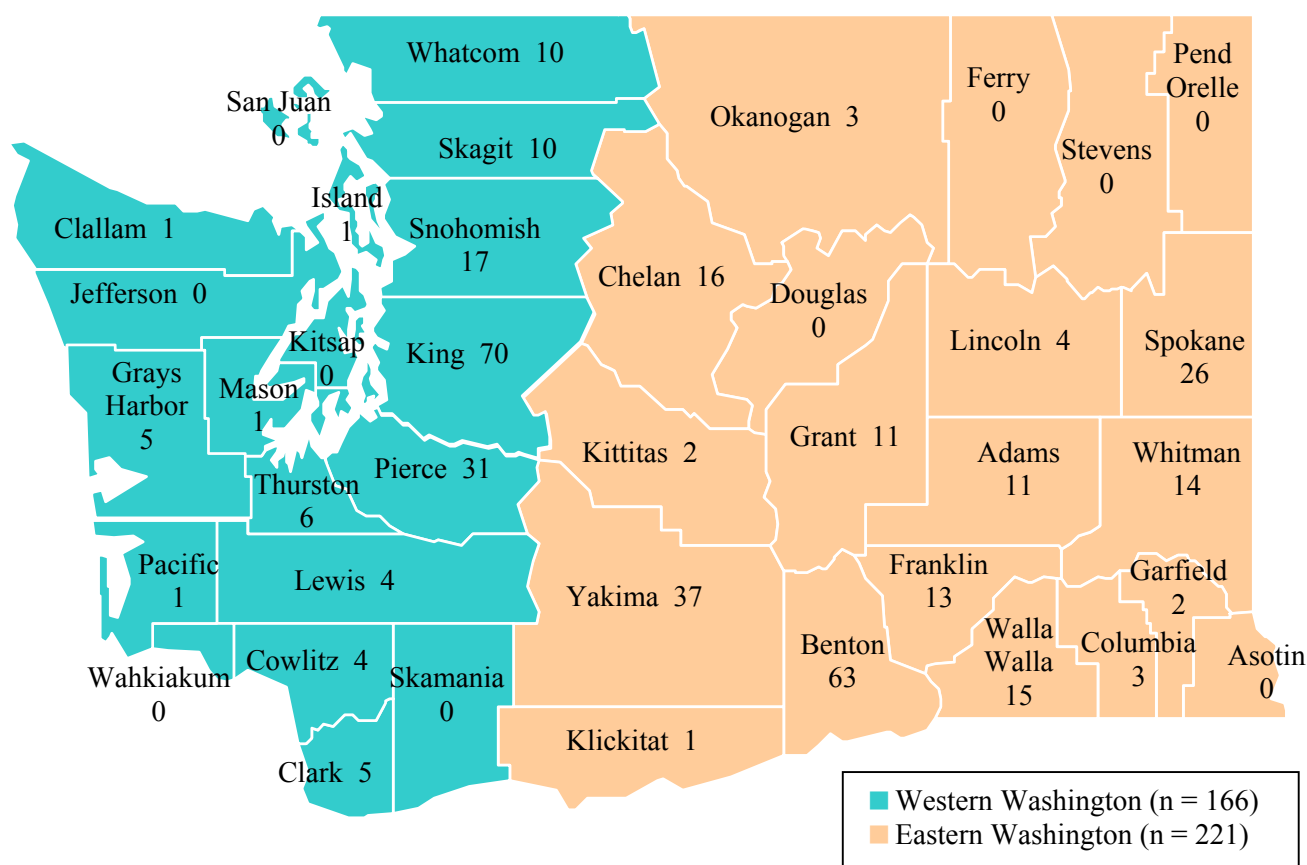
*Other (1999 = 5), Not Recorded (1999 = 4), Beyond Human Control (2001 = 2), Improper Filling/ Overfill (2000 = 2), Power Failure/ Electrical Problems (2000 = 1, 2001 = 1), Unauthorized/ Improper Dumping (2001 = 1).

**The category Deliberate Damage/ Illegal Activity was added in 2001 to capture drug lab related events. Prior to 2001, events related to drug lab releases were classified into the other categories (i.e. A leaking cylinder from a drug lab was classified as Equipment Failure).

Regional Comparison

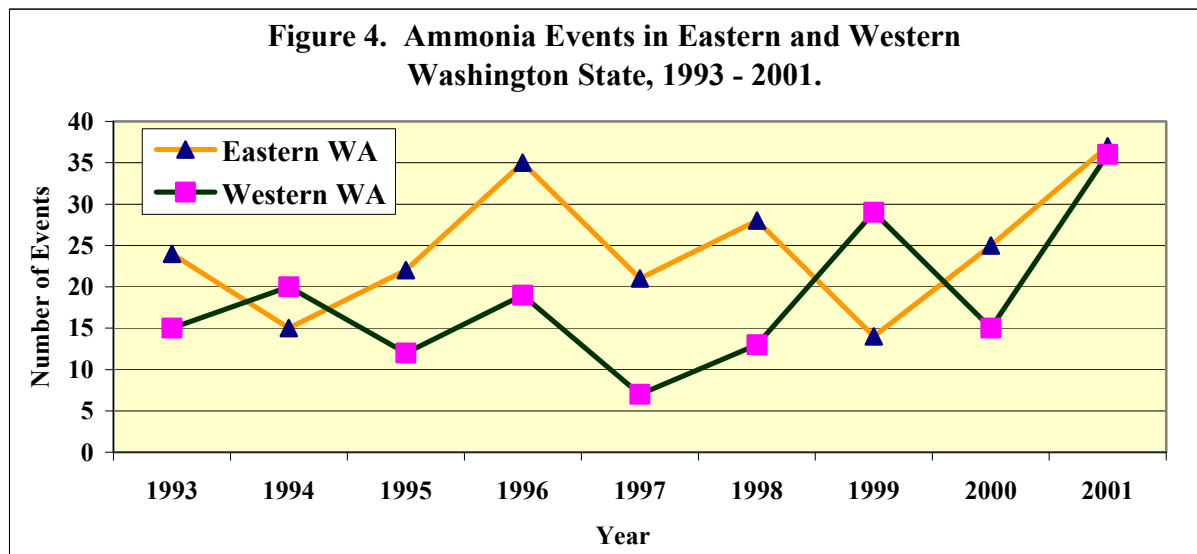
Figure 3 shows a map of Washington State and the number of ammonia events in each county during 1993 through 2001. Eastern Washington had 57.1% of the ammonia events with Benton County having 28.5% of the incidents. Benton County has companies that manufacture fertilizers and industrial chemicals. Yakima County, which has facilities with refrigeration systems for agricultural products, had 16.7% of the ammonia release events in Eastern Washington. Western Washington had 42.9% of the total events. King County, which has companies with refrigeration systems to support the fishing and dairy industries, accounted for 42.2% of the ammonia events in Western Washington.

Figure 3. Ammonia Events by County in Western and Eastern Washington State* (1993 – 2001).



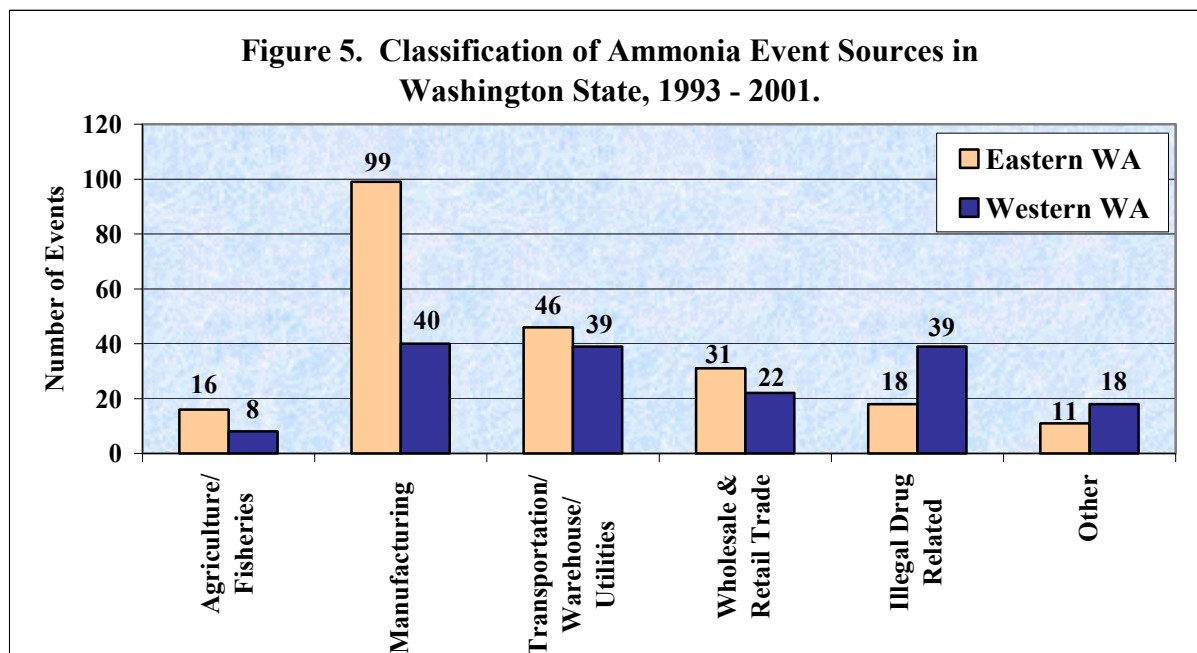
*The eastern and western division of Washington State was made along the western borders of Okanogan, Chelan, Kittitas, Yakima, and Klickitat counties. Counties west of this division were designated Western Washington and counties east of this division were Eastern Washington.

A comparison of ammonia events in Eastern and Western Washington in Figure 4 shows that Eastern Washington had the greater number of events most years. In 1993 through 2000, industries involved in refrigeration or manufacture of chemicals were the most frequent contributors to ammonia release events. In 2001, illegal drug lab related releases were the most frequent source of ammonia events.



Sources of Ammonia Releases by Region

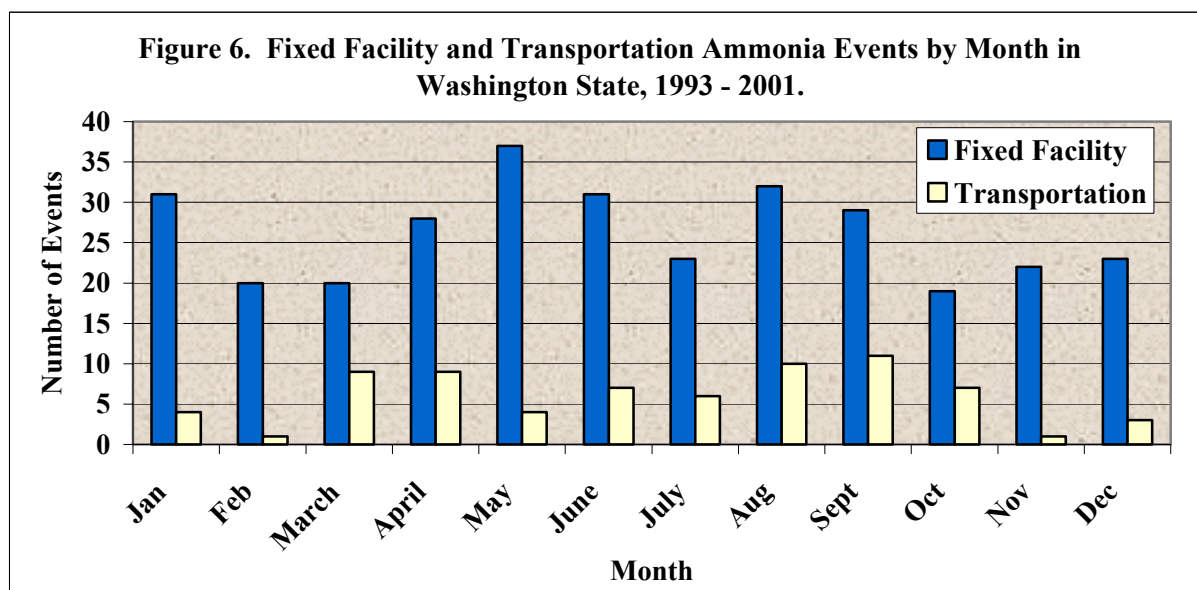
Using the ATSDR industrial classification system, ammonia release events were grouped into six general categories (Figure 5, below) to get an understanding of the release site sources in Washington State. It is important to note that 2001 was the first year the HSEES program began identifying methamphetamine related events involved in other industries (i.e. Fuel dealers exposed to ammonia fumes when illegal drug manufacturers store ammonia in propane tanks are classified under “Retail Trade”).



- **Agriculture/Fisheries:** Eastern Washington had sixteen ammonia events involving agriculture production or service facilities and Western Washington had eight events all involving the fishing industry located in King County.
- **Manufacturing:** Manufacturing of non-durable goods ([see Appendix II](#)) in the eastern part of the state accounted for 98 of the ammonia events; one event involved the production of durable goods. Agricultural chemical production and preserved fruit and vegetable manufacturing were the most frequent industries involved in ammonia releases in Eastern Washington. Western Washington had 37 ammonia events from facilities manufacturing non-durable goods and three events from industries involved in durable goods production. The industries with the most frequent ammonia releases in manufacturing of non-durable goods were dairy facilities, preserved fruit and vegetable manufacturers, and producers of miscellaneous food preparation products.
- **Transportation/Warehouse/Utilities:** Eastern Washington had 14 transportation ammonia events, 29 warehousing and storage events, and three utility events involving sanitary services. Western Washington had 14 transportation events, 21 warehousing and storage events, and four utility events (one of which involved illegally dumped methamphetamine lab chemicals released after pickup by a sanitation truck).
- **Wholesale & Retail Trade:** Eastern Washington had 31 events involving wholesale and retail trade businesses. Wholesale trade industries involving farm supplies and groceries and related products had the highest frequency of ammonia events. One event occurred as a result of ammonia theft at a refrigeration equipment sales business. Western Washington had 22 events involving businesses in wholesale and retail trade. Although the majority of events came from businesses selling groceries and related products, three events involved retail propane dealers exposed to ammonia from cylinders that had been altered by methamphetamine manufacturers.
- **Illegal Drug Related:** Eastern Washington had a total of 18 ammonia release events involving the manufacture of methamphetamine, 16 of which were recorded in the year 2001. Western Washington had 39 ammonia events involving methamphetamine manufacture and 24 of these events were recorded in 2001. Most illegal drug lab related events involved private residences, followed by dumpsites, and labs located in vehicles.
- **Other:** Eastern Washington had five ammonia events involving entertainment and recreation businesses. Other sites that had one ammonia event each included a private residence, a construction site, a college, and a hotel/motel methamphetamine lab. Two events involved an unknown industry. Western Washington had four private residence ammonia events and four involving construction projects. Four ammonia events involved professional services, two involved a drug lab in a hotel/motel, one event occurred at an elementary school, and one at an entertainment and recreational business. Two events involved an unknown industry.

Fixed-Facility vs. Transportation

Events are designated according to whether they occur at a fixed facility or are transportation related. Figure 6 shows the number of fixed facility and transportation ammonia events by month in 1993 through 2001. About 81% (315) of ammonia events occurred at fixed facilities and almost 19% (72) involved modes of transportation. No obvious seasonal trends are apparent, although the months of April through September have a total of 180 (57.1%) fixed facility events compared to 135 (42.9%) events during the months of October through March. Transportation events show a similar trend in which the months of April through September account for a total of 47 (65.3%) events and the months of October through March have 25 (34.7%). This may be attributable to the greater use of ammonia products for agricultural purposes during the warmer months.



Summary

Ammonia is a corrosive chemical that can cause serious respiratory problems, irritation or burns to the skin and eyes, and in extreme cases, death. Ammonia is a colorless gas with a strong odor and is often used in water solution. It is used in making fertilizers, as a refrigerant, and as an ingredient in the illegal manufacture of methamphetamine. There were 387 ammonia release events reported in Washington State in 1993 through 2001. A total of 402 people were injured during ammonia events and over 7,500 people were evacuated because of ammonia releases. Of those injured, 42% were members of the general public, 40% were employees, and 18% were first responders. Almost three fourths of those injured experienced respiratory problems. Eastern Washington had 57.1% of the ammonia events and Western Washington had 42.9%. Industries involved in manufacturing were the most frequent source of ammonia releases, and equipment failure was the most frequent cause of the events. Fixed facilities accounted for 315 of the ammonia events and 72 involved modes of transportation.

Special Notes on Anhydrous Ammonia Used For Methamphetamine Production

- Criminals prefer to manufacture methamphetamine using anhydrous ammonia (“Nazi Method”) because many of the other chemicals needed to make the drug are commercially available. The anhydrous ammonia also greatly speeds up the cooking process.
- Thefts have occurred where anhydrous ammonia is used as a refrigerant and at facilities that use ammonia for agricultural purposes. Criminals are often forced to abandon the theft site when the fumes become too strong, leaving tubes, buckets, duct tape, and makeshift containers behind. Valve locks, fences, or other theft deterrent devices can deter thefts at facilities that store ammonia.
- Anhydrous ammonia corrodes brass valving, turning the brass to a blue/green color. Such corroding on a propane tank signals the presence of ammonia and such containers should be handled with extreme caution because the integrity of the valving has been compromised and the valve could break off, releasing the contents.
- Responders should take care in selecting the proper personal protective equipment. The use of self-contained positive-pressure breathing apparatus is appropriate during a response to an anhydrous ammonia release and in some cases it may be necessary to wear cryogenic gloves with a moisture barrier.

Acknowledgements

The HSEES program is grateful for the cooperation of local emergency responders, industrial leaders, and agencies mandated to manage hazardous releases. The information that is provided to us significantly contributes to developing accurate profiles of hazardous material events in Washington State.

Appendix I. Resources

To report a release of any hazardous material, please contact the Washington State Division of Emergency Management: 1-800-258-5990.

For further information about ammonia and the health effects from ammonia exposure, please refer to the following:

U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, Ammonia Fact Sheet.

www.atsdr.cdc.gov/tfacts126.html

U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, NIOSH Occupational Health Guidelines for Chemical Hazards Master Index.

www.cdc.gov/niosh/chem-inx.html

Washington State Legislature, WAC 296-24-51003

www.leg.wa.gov/wac/index.cfm?fuseaction=section§ion=296-24-51003

U.S. Department of Labor, Occupational Safety & Health Administration, Safety and Health Topics: Ammonia Refrigeration. www.osha.gov/SLTC/

Additional copies of this report and other reports may be downloaded from the Washington State HSEES website: www.doh.wa.gov/ehp/ts/HSEES.HTM

Appendix II. Classification of Durable and Non-durable Goods

The ATSDR Industrial Classification System classifies the following as “Durable goods”:

- Lumber and wood products, except furniture
- Furniture and fixtures
- Stone, clay, glass, and concrete products
- Metal industries
- Machinery and computing equipment
- Electrical machinery, equipment, and supplies
- Transportation equipment
- Professional and photographic equipment, and watches
- Toys, amusements, and sporting goods
- Miscellaneous manufacturing industries

The following are classified as “Non-durable goods”:

- Food and kindred products
- Textile mill products
- Apparel and other finished textile products
- Paper and allied products
- Printing, publishing and allied industries
- Chemicals and allied products
- Petroleum and coal products
- Rubber and miscellaneous plastics products
- Leather and leather products